University-Based Pulsed Neutron Sources: The LENS Project

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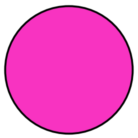
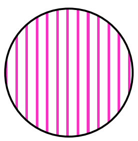
OUTLINE

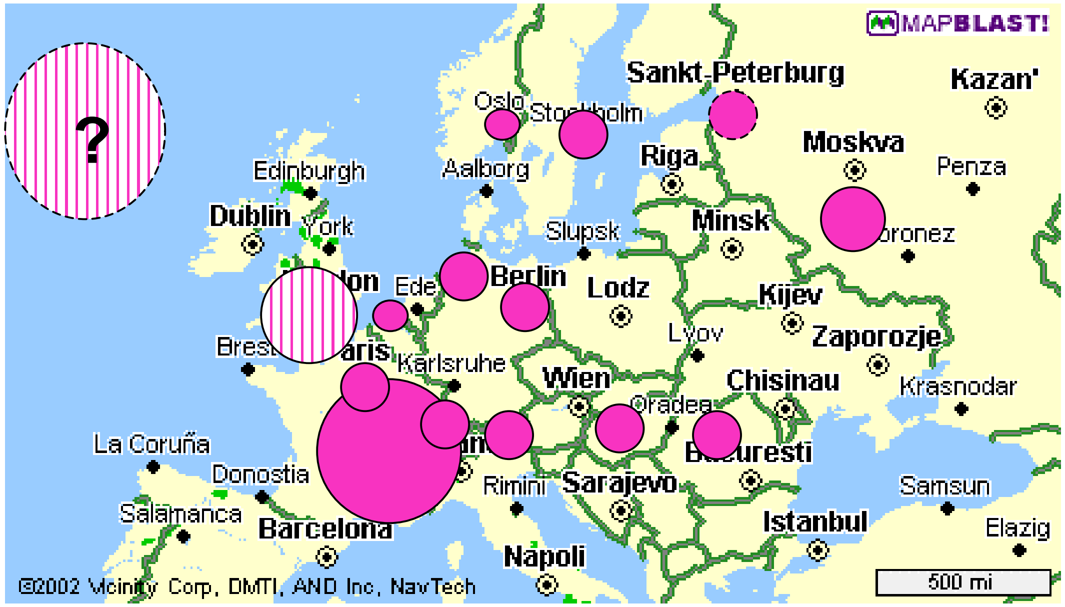
- Why build a pulsed neutron source at a University?
- How can it be done?
- What will be done at this facility when it is built?
- Conclusions



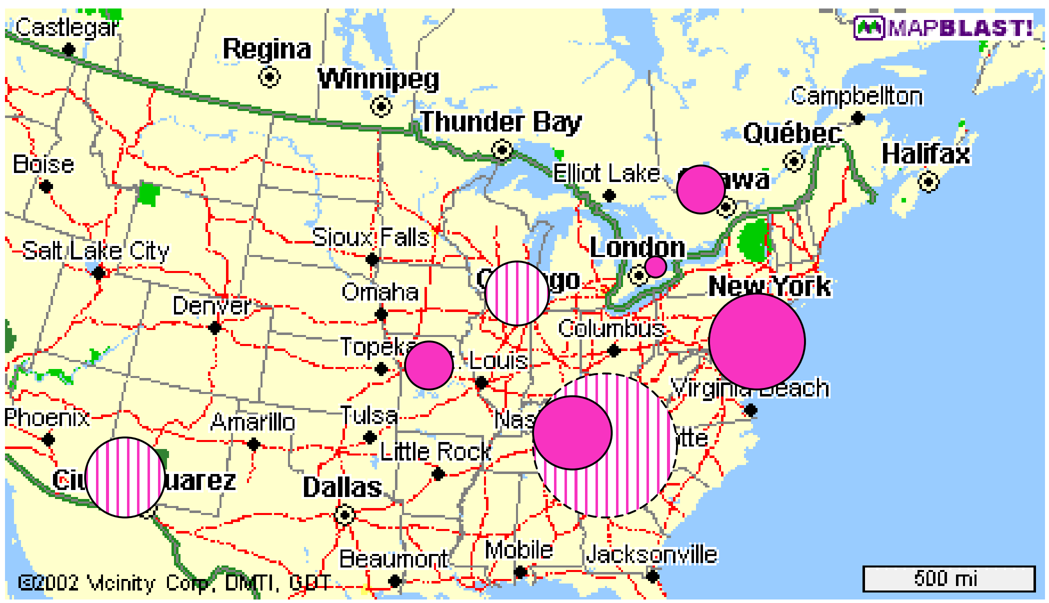
Reactor



Pulsed



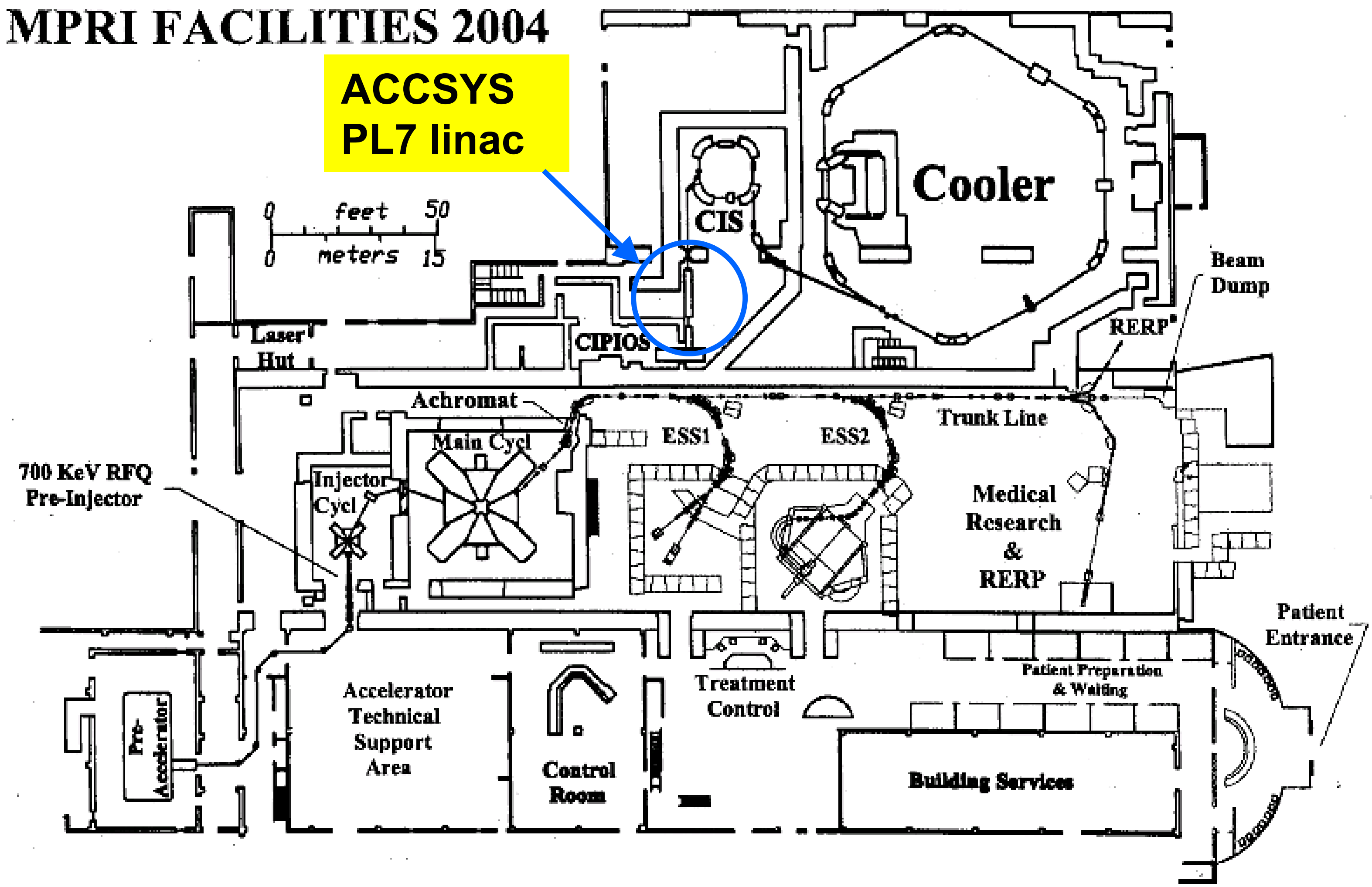
Neutron Sources



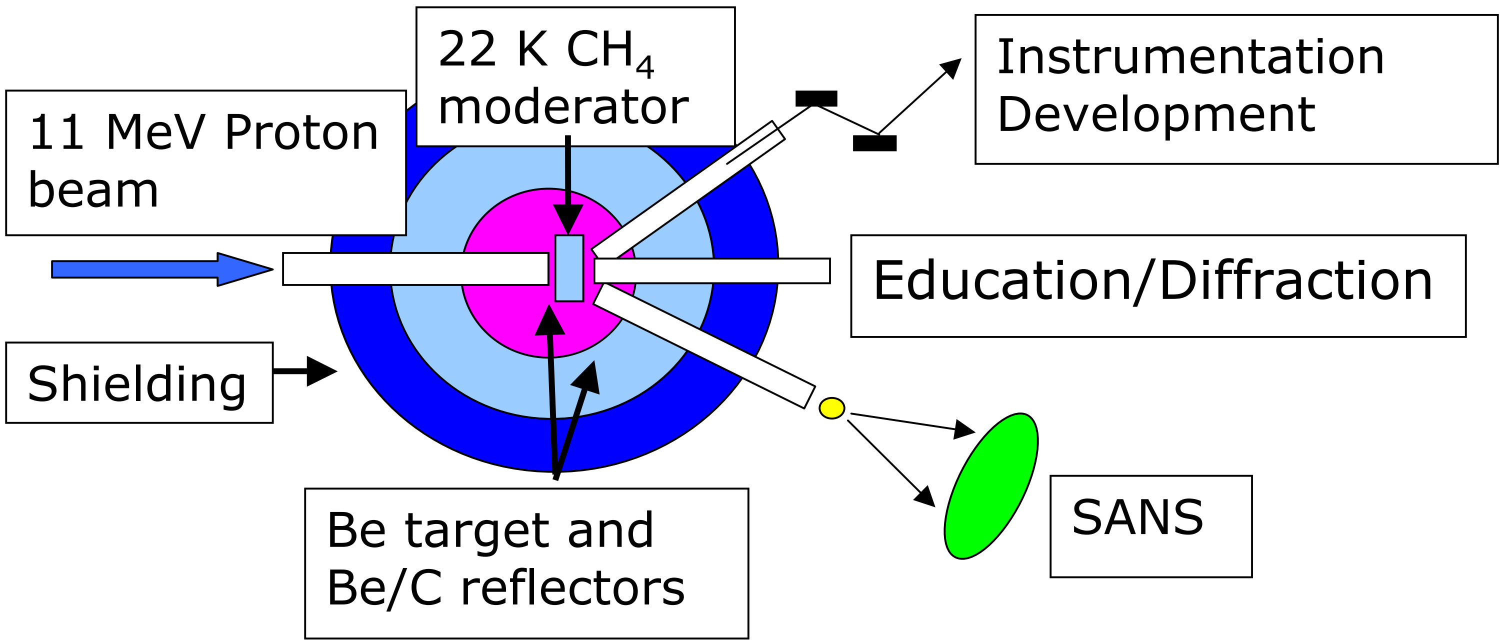
What is LENS?

- **Low Energy Neutron Source**: based on low-energy (p,n) and (p,pn) reactions (E_p<11MeV) in Be.
- The source will be tightly coupled to a **cold moderator** (solid CH_4 at about 22K).
- LENS will have a **variable pulse width** (from 100μs to 1.0 ms or more).
- In long-pulse mode, LENS will have a **time-averaged cold neutron intensity greater than the IPNS (1 moderator).**
- A small number of scattering instruments will be developed to utilize these neutrons.

Existing Infrastructure



Low Energy Neutron Source



Distinct Features of LENS

- Its ***low proton energy*** makes LENS ideal for **studies of new moderator materials and designs.**
- No high-energy (E>10MeV) neutrons and few γ's allows **shorter instrument design, reduced costs**, and **reduced backgrounds (also UCN candidate).**
- Its ***long (but variable) pulse width*** makes LENS suitable for **Small Angle Neutron Scattering (SANS)** and for **developing instruments for future long-pulse spallation sources.**
- Its ***low cost*** (both capital and operating) allows large amounts of beam time to be devoted to **education of new users, particularly those in non-traditional fields (Chemistry, Biology)**

LENS: The numbers
(11MeV, 2.5mA, 22K CH_4 slab moderator)

(5% DF; 900μs proton pulses)

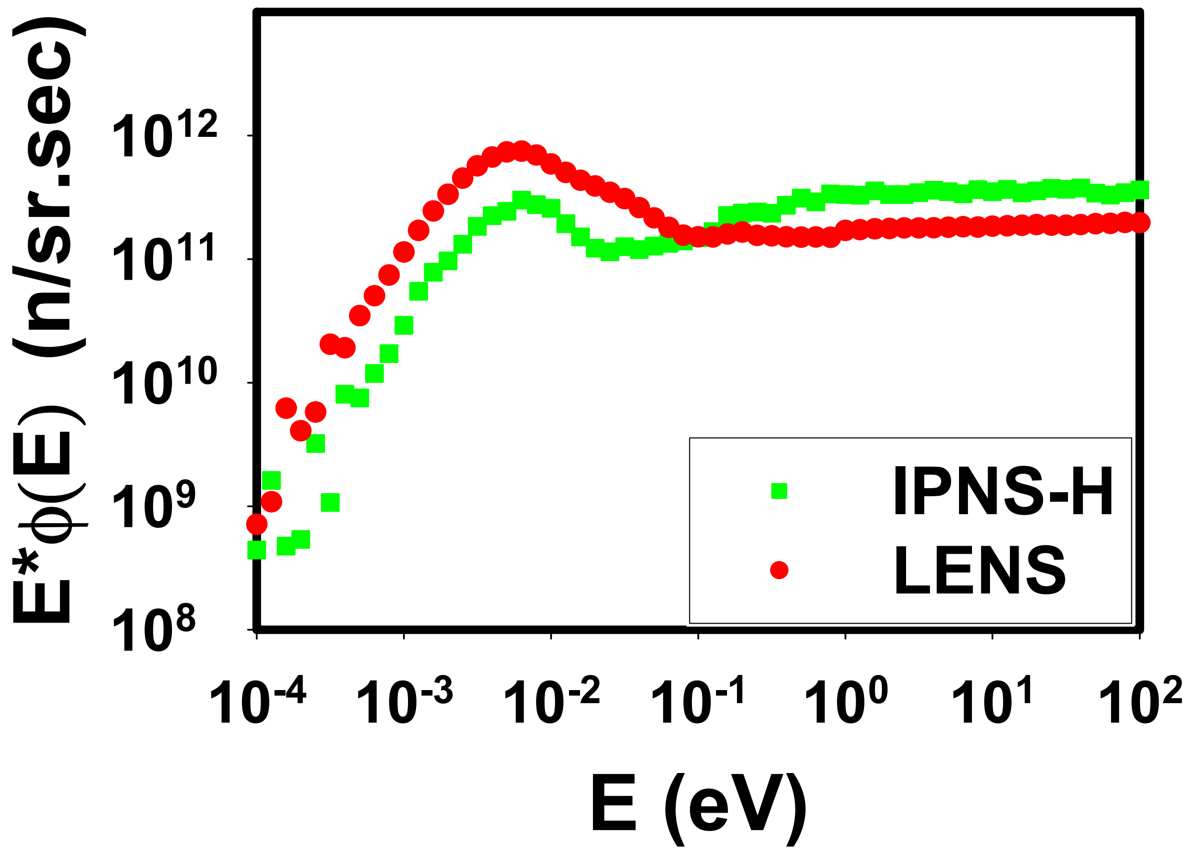
- Primary neutrons: **10^{14} /s**
- Peak Mod. Bright.: **2×10^{12} n/cm^2.s.sr.eV**
- Flux @ 5.0m: **7×10^{6} n/cm^2.s**

  (0.7-33meV,uncol.)
- SANS flux: **>3×10^{5} n/cm^2.s**

  (1.06-0.16nm,col.)

Based on MCNP and NISP calculations. Does not include: Grooved moderator, composite target and/or moderator, …

Neutron Energy Distribution

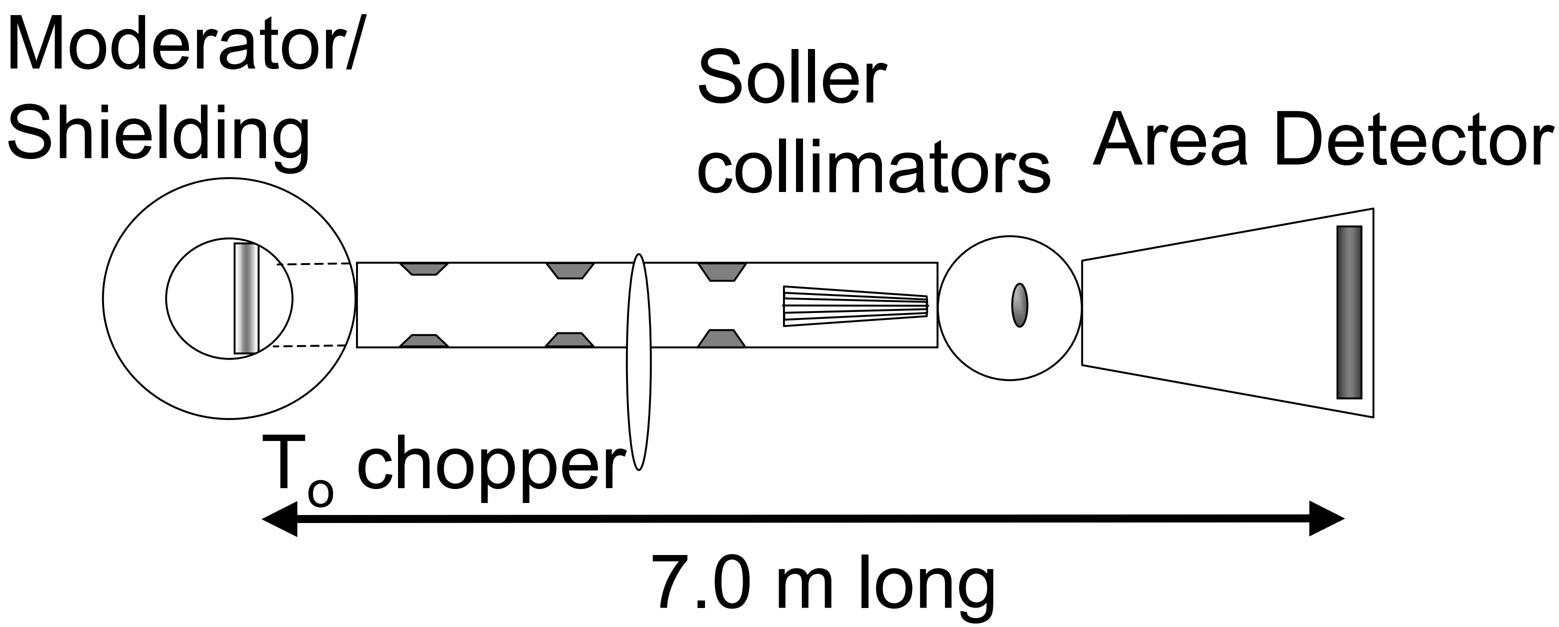


Derived from MCNP calculations similar to those vetted on the IPNS-H moderator (Iverson99).

So why does LENS work?

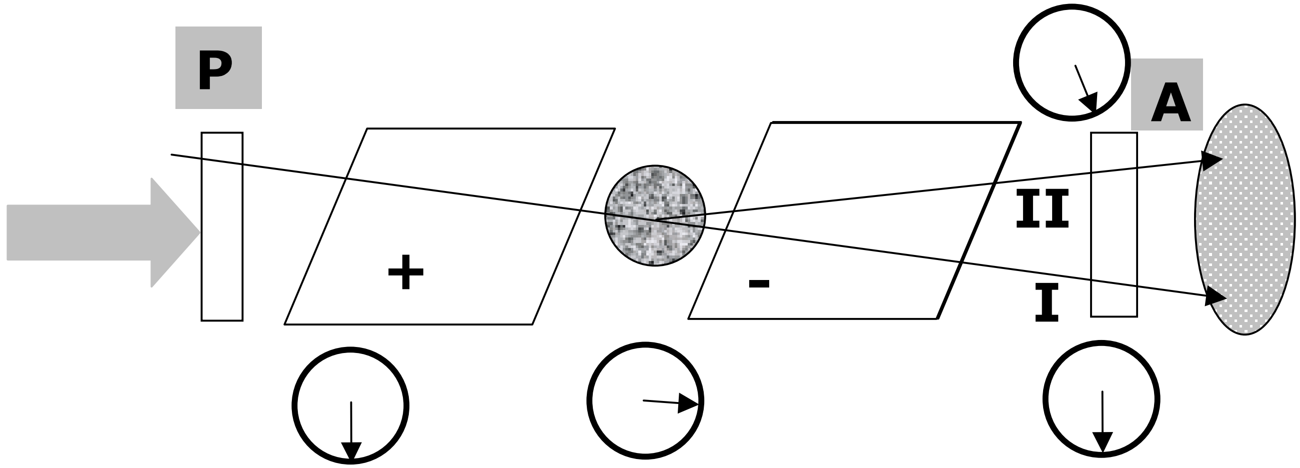
Feature	LENS/IPNS
• Nuclear efficiency	1/2500
• Larger average current	200
• No decouplers/poisons	6
• Geometric Coupling	2-5
• Lower energy spectrum	1.2-5
• Overall	1-3

Conventional SANS



Roughly equivalent to the **SAD** instrument at **IPNS**

Spin-Echo SANS



- Encode momentum info in neutron SPIN!
- Resolution is decoupled from the incident beam phase space!
  (NO COLLIMATION NEEDED in the encoded direction!)
- Max length scale probed is set by the maximum B field;
  0.1T ⇢ microns!
- Variations on the theme allow high-resolution diffraction,
  SAS, reflectometry etc. (stay around for Roger Pynn's talk!)

CONCLUSIONS

- LENS will have a time-averaged cold neutron intensity greater than that available from a single moderator at the IPNS in a university setting!
- The LENS time structure is most suited to SANS (for max. flux) but is flexible for instrumentation and moderator development and can be used for a variety of other techniques with suitable instrumentation.
- LENS can play an important role in building the user base needed to support the SNS, it is our hope that a network of such sources will be built.
- By combining SANS, SESANS, and phase-contrast radiography, LENS will be able to investigate materials structures over 7 orders of magnitude in length scale.